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Insect Pests of Truck and Garden Crops

By

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CORVALLIS, OREGON

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Insect Pests of Truck and Garden Crops

By

Don C. Mote

INSECT CONTROL

Clean gardening. It is desirable to start the year as free from insect pests as possible. In the fall of each year all crop remnants should be gathered together and burned. Composting such material does not always destroy the plant pests in the left-over material. Weedy or grassy borders around or near the garden should be burned over in late fall or early spring to reduce hibernation places and to destroy the weeds on which injurious insects may breed and from which they may spread to cultivated crops.

Crop rotation. Insect attack may be reduced by a proper system of rotation in which the same crop is not planted on the same land for a series of years and in which crops that are attacked by the same insects do not succeed each other.

Fertilizers. The proper use of fertilizers may enable injured plants to repair damage quickly and thus overcome insect attack. Such soil forms as the onion-maggot and seed-corn maggot flourish in certain fertilizers made from animal remains and decaying material, such as decaying alfalfa sod, but mineral fertilizer renders the soil less congenial for them. Tobacco dust from which the nicotine has been extracted is a good organic fertilizer and decreases some soil forms as well as lessens the number of lice which often gather on the under side of leaves of garden plants.

Cultivation. Thrifty, rapid, vigorous growing plants produced by thorough and frequent cultivation are more resistant to insect attack.

Farm animals as insect destroyers. Chickens, ducks, and turkeys in the garden whenever feasible will devour many cutworms, slugs, grasshoppers, and the larvae of injurious beetles. Hogs turned into the garden for a few weeks in the fall or spring will root out and devour many white grubs, wireworms, and other pests.

How insects are spread. Insects may be introduced into gardens in one or more of the following ways: (1) on infested plants which may be purchased from the local seed store or gardener; (2) in the soil or manure used in replenishing or fertilizing the garden; (3) by being harbored in the garden soil through the winter; (4) on infested weeds or other vegetation growing in close proximity to the garden, from which insects may fly or crawl to the garden; (5) in dry beans and peas from which adults fly to the gardens in early spring.

How insects feed. The effective application of insecticides depends upon an understanding of the character of the mouth-parts of insects, as well as a knowledge of the life-history of the pests. The character of the mouth-part determines the kind of insecticide to be used. In general, insects may be divided into two classes: (1) biting and (2) sucking insects.

The biting or chewing insects actually masticate and swallow portions of the solid substance of the plant. These insects include the larvae or caterpillars of moths and butterflies, beetles and their larvae, and grasshoppers. Provided they feed in situations where poisons may be applied and eaten along with part of the plant, *chewing insects may be destroyed by arsenical or stomach poisons.*

Sucking insects injure the plant by the gradual extraction of the juices from the leaves and stems, and include plant lice or aphids, leafhoppers, plant bugs, and plant-feeding mites. These insects are provided with sharp, piercing mouth-parts, which are inserted into the tissues of the plant and through which they suck the vital juices. *Sucking insects may be controlled by contact poisons* which act externally upon their bodies, penetrating their breathing pores or otherwise causing their destruction.

Spraying not a cure-all. Although the use of insecticides is essential to the highest production of first-class truck and garden crops, spraying will not remedy all the troubles arising from neglect and abuse. Sound seed, a well-prepared seed-bed, and keeping the plant in a clean, thrifty, growing condition constitute the initial step in combating its enemies. The judicious rotation of crops; fall, winter, and early spring plowing; proper time of planting; adequate use of fertilizers; use of trap crops; and frequent examination of young plants for possible insect pests—each of these practices constitutes an important factor in the control of insect pests.

When spraying, be sure the proportions are correct, then mix thoroughly. A thorough mixture of a liquid spray is best obtained by pumping the solution through the hose and back into the container. Keep the solution thoroughly agitated while spraying. Do not continue to spray until the material runs from the plant; cover the plant with the solution and then stop. An angle nozzle aids materially in the ease of application of the spray. For practically all truck and garden crops, the spray is best applied as a fine mist, and for best results a considerable pressure should be maintained.

For the small plants of all vegetables and at all stages in the growth of particularly tender plants, dusting is advisable. There is apparently less danger of burning in the application of an equal amount of poison in the powdered form as compared with a liquid spray.

The best *type of sprayer* will depend upon the work to be done. For the larger commercial truck growers, the power sprayers are most acceptable. For the smaller growers, the barrel or barrow type of spray pump will recommend itself. The knapsack and small, compressed-air pumps fitted up for a variety of purposes are very efficient in a small way. The general-purpose spray pump should have working

parts of brass that are accessible and replacable. Always wash out the hose and working parts of the pump with water after using.

A dust spray gun for the application of dust insecticides should be obtained. There are small hand-bellows types that are very good for small areas, and large powder guns fitted with a fan wheel and extensions suitable for almost any purpose.

INSECTICIDES

Broadly speaking, as already stated, we must use stomach poisons for those insects which chew their food or devour foliage, and contact poisons for those which suck their food through a beak. Gas fumigation is used against inaccessible insects such as stored-grain pests which cannot readily be reached by other treatments.

STOMACH POISONS

Most of the stomach poisons have arsenic as the active ingredient. They include white arsenic, London purple, paris green, zinc arsenate, calcium arsenate, lead arsenate, and hellebore. The insecticides recommended for general use, because they are so uniformly standard and high grade, giving maximum efficiency in insect control and minimum injury to plants, are lead arsenate and calcium arsenate.

Lead arsenate. This is our standard high-grade poison insecticide. The powdered form of lead arsenate is preferable for general use. Where the paste form is employed double the amounts given in the spray formulae.

As a spray it may be used in the following proportions:

2 pounds (powdered) to 50 gallons water.

⅔ ounce to 1 ounce (10 level teaspoonfuls) to 1 gallon water.

In preparing the solution the arsenate should first be made up into a thin paste by the addition of a small quantity of water and then diluted to the required strength. On smooth or waxy foliage such as cabbage the liquid does not stick very well. This difficulty is overcome by adding a "spreader" such as a commercial calcium caseinate spreader, skim milk, fish-oil soap, or any common laundry soap at the rate of 3 pounds to 50 gallons of spray, or ½ to 1 ounce to 1 gallon for smaller quantities of spray.

Calcium arsenate is possibly not so uniformly high grade as lead arsenate. For general use in truck and garden spraying, however, except on the younger and more tender foliage, it may be substituted for lead arsenate. It has a higher killing efficiency than the lead arsenate and for garden slugs is the only satisfactory poison material for use in the bait. Dealers in general, because of the previous small demand for calcium arsenate, have failed to stock up on this insecticide. Its value is so apparent in the control of garden insects that growers would do well to see to it that local dealers have calcium arsenate available for use. When used as a foliage spray an equal weight of quicklime or good hydrated lime should be added to prevent foliage burn.

Applying the spray. Formerly the accepted method of applying insecticides was as a liquid spray. This method is still useful in the application of contact insecticides. In the application of poison insecticides in general to garden and truck crops, however, the dusting method is equal to and in some ways superior to the liquid spray. Dusts stick better to the slick foliage of plants such as cabbage. They generally make possible a more even and a more complete covering, and apparently do not burn tender foliage so readily. One of the various types of dusters to be obtained from any dealer in spray materials is preferable in applying dust. Dust in some cases may be applied satisfactorily through a coarse sack or cheese-cloth bag.

Formula for dust spray. It is inadvisable to apply the poison dust at full strength. Dilute with some inexpensive carrier as follows:

Arsenate of lead or calcium arsenate (by weight)..... 1 part.
Sifted wood ashes, air-slaked lime, or sulfur (by weight)..... 6 parts.

Be sure the materials are thoroughly mixed; apply lightly. Best results are obtained when there is no wind blowing. Commercial arsenate dusts may be purchased from your local dealer.

Paris green is an arsenical compound which, while formerly widely used, has fallen into disuse owing to its tendency to burn the foliage. It is an efficient insecticide, however, and is also used as an ingredient in a poisoned bait for sow-bugs, slugs, and millepeds. The formula recommended consists of one part of paris green to nine parts of sugar. Mix thoroughly and sprinkle lightly over the soil. In its application care should be exercised to prevent it from coming in contact with tender foliage, otherwise severe burning may result. When used as a foliage spray, an equal weight of lime should be added to neutralize any soluble arsenic present and thus prevent burning of the foliage.

White arsenic is a very active stomach poison, but its use on plants is precluded because of severe burning likely to follow. On account of its cheapness it is finding increased use in poisoned baits as a substitute for paris green.

Hellebore is a powder that may be used either as a liquid or a dust against immature larvae of many leaf-feeding insects. It is especially useful on crops nearly ready for harvest where other materials might prove objectionable. For use it is made as follows:

Liquid
Hellebore .....4 ounces
Water .....2 to 3 gallons

Dust
Hellebore .....1 ounce
Air-slaked lime, sulfur, or cheap flour 5 to 10 ounces

Poisoned bran mash. Besides being an excellent remedy for grasshoppers and cutworms, poisoned bran mash is also an effective poison

for control of sow-bugs, millepeds, ants, and crane-fly larvae. The poisoned mash is prepared as follows:

Coarse bran	25 pounds
Paris green or white arsenic	1 pound
Salt	¼ pound
Molasses	1 pint

Use water to make a coarse, crumbly mash. The white arsenic and dry bran are first mixed thoroughly in a container. In another vessel stir a pint of cheap molasses or sirup in 3 to 4 quarts of water. Then prepare a mash by slowly adding the mixture of molasses and water to the poisoned bran. If too dry more water may be added. The mash, however, should not be made too sloppy; it should fall apart readily in the hand after being pressed together.

Scatter thinly over the surface of the soil along the rows of plants after sundown.

CONTACT POISONS

Commercial nicotine sprays are very generally used for the control of many soft-bodied sucking insects such as plant-lice and thrips. They may be purchased from your local dealer under many proprietary names, either in volatile or non-volatile form. These solutions are easily diluted to the required strength, or may be combined with the standard stomach poisons and fungicides. Directions for mixing and applying the nicotine sprays may be found upon the container.

Nicotine oleate is a new contact insecticide recently developed. It may be prepared from any nicotine preparation containing "free" or volatile nicotine. It is made as follows:

Volatile or "free" nicotine solution (40 percent nicotine)	10 parts
Oleic acid or red oil	7 parts

This makes a stock solution of the consistency of soft soap. For spraying, the stock solution is further diluted as follows:

4 to 8 tablespoonfuls stock solution to 1 gallon water.

Kerosene nicotine oleate is useful against such soil pests as sow-bugs, earthworms, ants, and millepeds; it is also an effective contact insecticide. A stock emulsion of kerosene nicotine oleate is prepared as follows:

Solution 1.

Kerosene	8 parts or 1 gallon
Oleic acid	1 part or 1 pint

Solution 2.

Volatile nicotine (40 percent)	2 parts or 2 pints
Water	8 parts or 1 gallon

Solution 1 is prepared by slowly pouring the oleic acid into the kerosene, stirring constantly. In another vessel make up Solution 2 by

adding the volatile nicotine to the water. The stock emulsion is then prepared by stirring Solution 1 into Solution 2 and bringing the mixture to a creamy consistency by churning it rapidly for several minutes, or pumping the liquid back upon itself through a bucket spray pump. For use against soil pests use 1 pint of the stock emulsion to 10 to 12 gallons of water and spray the soil infested with these pests.

Tobacco dust consists of finely ground tobacco stems and other refuse from tobacco factories. Because of its low percentage nicotine content and low volatility of the nicotine, tobacco dust is not a very effective insecticide under Oregon conditions.

Nicotine dust consists of finely pulverized kaolin, or hydrated or air-slaked lime, or sulfur or other suitable carrier impregnated with nicotine sulfate solution containing 40-percent nicotine. This dust, containing from 2 to 5 percent by weight of nicotine sulfate, may be purchased from your local dealer under many proprietary names.

The essential conditions for effective control with nicotine dusts appear to be percentage nicotine present in dust, high temperatures, little or no air currents, freedom of foliage from heavy dews.

Sulfur. For the destruction of the two-spotted mites or "red spiders" sulfur in some form is now extensively used. The form of sulfur in most common use among vegetable growers is finely powdered or superfine sulfur. Commercial ground sulfur or dusting sulfur is as effective as the more refined flowers of sulfur, provided it is finely powdered. For use sulfur is usually diluted with equal parts of a carrier, such as hydrated lime, gypsum, kaolin, or flour, and applied with a dust gun. The following mixtures have been recommended for mites and leaf-chewing insects:

Superfine sulfur	9 parts
Arsenate of lead	1 part

and for mites, leaf-chewing insects and sucking insects:

Superfine sulfur	8 parts
Arsenate of lead	1 part
Tobacco or nicotine dust	1 part

"All-in-one" or "Three-in-One" is a commercial powdered insecticide containing arsenate, nicotine, and sulfur. For small gardeners particularly, who hesitate to take the trouble to prepare their own insecticides, this dust is very convenient. It serves better as a preventive than a cure. Dust young plants with the material at twelve-day intervals.

Kerosene emulsion is usually prepared as a stock solution and then diluted to the required strength for spraying, as used.

Whale-oil soap	½ pound
Water	1 gallon
Kerosene	2 gallons

Dissolve the soap in the boiling water. Remove from the fire and add the kerosene, stirring vigorously. The solution must now be agitated until it assumes a thick creamy consistency that does not separate

on cooling. This condition is most readily brought about by the use of a small bucket pump, forcing the solution through the hose and back into the container.

About a 7-percent solution will serve for most of our truck and garden pests. Some crops will permit a heavier dosage, and in a few cases a weaker dilution is advisable. The following dilutions will probably serve all ordinary purposes. The figures are given on the basis of 1 gallon of the stock solution.

To obtain 4-percent solution, add 15⅜ gallons of water
To obtain 7-percent solution, add 8½ gallons of water
To obtain 12-percent solution, add 4½ gallons of water

Oil sprays are best applied on bright days and when there is a slight breeze.

Fish-oil soap. Especially good as a dip for young plants, to free them from plant-lice, etc., is the following:

Caustic soda	1½ pounds
Water	1½ quarts
Fish-oil	5½ pounds

Dissolve the caustic soda in the water. Add the fish-oil slowly with constant vigorous stirring. To use, take 1 pound of soap to 8 gallons of water. Do not submerge the plants. Dip only the infested portion; i.e., the root or top.

Bordeaux mixture should be made fresh each time it is used.

Copper sulfate	1 pound
Quicklime	1 pound
Water	12½ gallons

Use only wooden or earthenware vessels in preparing bordeaux. Dissolve the copper sulfate in 2 gallons of water, in one vessel. Slake the lime and make up to 2 gallons in another vessel. Pour the two solutions simultaneously through a strainer into a container holding 8½ gallons of water.

FUMIGATION OR STERILIZATION

The use of destructive gases or heat is a most effective means of control of insects attacking seeds such as the bean-weevil and pea-weevil.

Heat. For the destruction of pests in small amounts of grain or similar products kept for culinary purposes in the home, the simplest method is to put the material in a shallow baking pan and place in the oven. To regulate the temperature, a pan of water may be placed in the oven, which should not become hot enough quite to boil the water. One hour of this treatment will kill all stages of the insects causing the trouble.

This treatment will destroy the germination of the seed and is not safe for rising flour. If seed is intended for planting care should be exercised not to allow the temperature to exceed 145° F., nor should the temperature fall below 130° F., during the treatments.

Carbon bisulfide is the most practical fumigating substance for the treatment of moderate quantities of beans and peas. It can be used for the treatment of seeds intended for planting, and foodstuffs are in no way injured when the gas is properly applied.

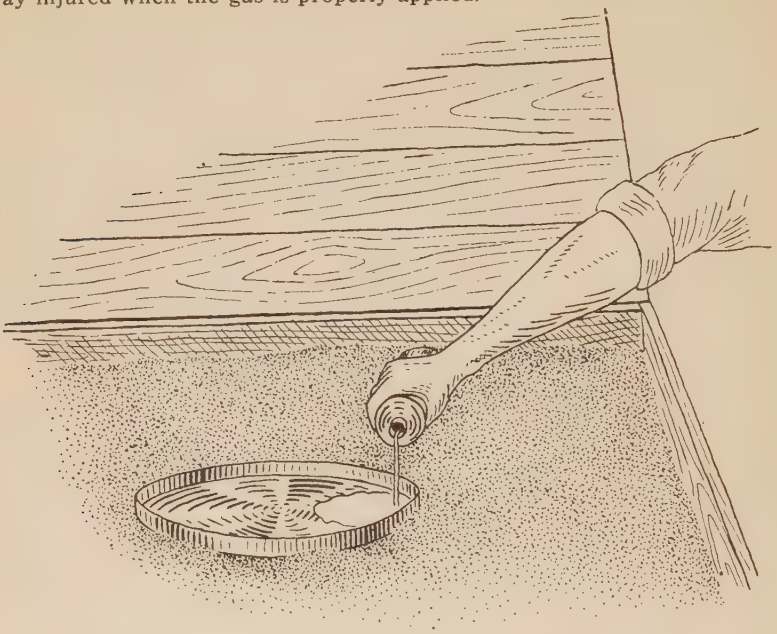

Fig. 1. Placing carbon bisulphide in bin.

Application. See that the room or containers are tight enough to hold the gas. The liquid carbon bisulfide may be obtained from any druggist. Six pounds should be procured for every 1000 cubic feet of space to be treated. For smaller amounts of material, the liquid should be used at the rate of 2 ounces (about 4 tablespoonfuls) for each bushel: for still smaller quantities a teaspoonful can be simply poured into a 2-quart Mason jar holding the material. If the temperature is low or if the gas can leak from the bin, a larger amount will be necessary. *Do not attempt to fumigate if the temperature is below 60° F.* The gas is ineffective below this temperature.

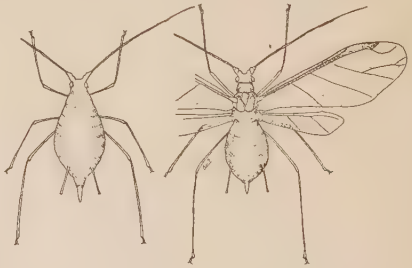

Fig. 2. Aphids—Winged and wingless forms (enlarged about 8X).

Carbon bisulfide is heavier than air, and tends to settle. The liquid should be placed in shallow pans *on top* of the material to be fumigated (Fig. 1). Where considerable surface is exposed it is well to divide the liquid and place it in pans at several points so as to obtain a more even distribution of the

gas. As soon as the liquid has been placed in position, immediately close the container. Allow the gas to act for from 24 to 48 hours. The bins or containers may then be opened and allowed to air out. *Caution.* Carbon bisulfide is very inflammable, in both the liquid and gaseous forms. Keep all lights, sparks, or flames away from it. Do not use in a heated room.

SOIL STERILIZATION

Carbon bisulfide may also be used in a limited way as a soil fumigant in the control of ants, root maggots, white grubs, and other soil-infesting insects. In applying carbon bisulfide for soil insects, the liquid is distributed in one or two holes made about 4 inches from the base of the plant, and to a depth of 4 to 12 inches. One teaspoonful in each hole will suffice for smaller plants and a tablespoonful for larger plants. The holes must be immediately closed with earth by tamping the soil with the foot.

Flooding of infested fields is of value against certain soil pests, as for example symphilids. The period of submersion may vary between two and sixty days, according to the nature of the soil treated and the type of pest to be destroyed. This type of control is feasible only where a plentiful supply of irrigation water is available.

Corrosive sublimate is frequently recommended where the aim of soil sterilization is primarily the treatment of soil around the roots of plants. Against the cabbage-maggot and onion-maggot this substance is used at a strength of 1 ounce to 12 gallons of water, being applied at intervals of a week or ten days during the flight period of the fly. Drenching the soil with the solution of corrosive sublimate is of value in combating earthworms, slugs, and larvae of fungus gnats.

The preparation and handling of this chemical should be safeguarded as *it is a deadly poison.* As it corrodes metals, the solution should be prepared in a glass, glazed, or wooden vessel which should be thoroughly cleaned or destroyed immediately after use.

GENERAL PESTS

Ants. Ants sometimes become somewhat troublesome in gardens. Their presence is generally associated with aphides or plant-lice, from which in return for their protection the ants obtain a "honey dew" or sweetish fluid. This they collect and transfer to their nests. This habit has led to the development of poisoned baits as a control.

Control. Poisoned sirup: Dissolve 15 pounds of granulated sugar in 7½ pints of water and add ¾ ounce of tartaric acid (crystallized). Boil these ingredients slowly for 30 minutes and allow to cool. Then dissolve ¾ ounce of sodium arsenite in ½ pint of hot water and allow to cool. Combine the two solutions by thorough stirring. Finally, add 1½ pounds of honey. Place the material in small cans containing excelsior. Place the cans in the ground, covering in such a way that the ants may have free access to the sweetened bait in the cans.

Certain species of ants are not attracted to this bait. These may be controlled by injecting a little carbon bisulfide, kerosene, gasoline, or

sodium cyanide solution into the opening of their nests. This method should not be used in direct contact with growing plants. Repeated applications of London purple or sodium fluoride to the nests has also been recommended. Pouring boiling water into the opening of the nest is of value. Soaking the nest with kerosene-oleate solution is also recommended.

Aphids or plant-lice (see Fig. 2), which attack most garden and truck crops are small, greenish, soft-bodied, pear-shaped insects clustered on the foliage and stems of plants. Their mouth-parts are fitted for sucking, and they pierce the surface tissues of the plant and suck out the plant juices. Arsenicals applied to the surface of the foliage are therefore of no value in the control of plant-lice.

Fig. 3. Cutworm feeding on tomato (slightly enlarged).

Plant-lice have a unique method of reproduction enabling them to increase in numbers at a tremendous rate. During the growing period of the plant, all the aphids present are asexual females capable of giving birth to living young at the rate of from one to six a day. These progeny are mature in twelve days, and in turn begin giving birth to living young. Both winged and wingless forms occur. One winged adult settling on a plant may in a comparatively brief time produce a colony of sufficient magnitude to devitalize the infested plant. The winged forms are continually flying to new hosts so that reinfestation often occurs soon after control sprays have been applied to the crop.

Control. Plant-lice are controlled by contact sprays (page 9). To be effective the solution must actually wet the insect. The use of nicotine or "all-in-one" dusts at frequent intervals on plants such as cabbage and peas will do much to keep down serious infestation.

Cutworms. The sleek, well-fed, greasy, sparsely-haired cutworm caterpillars (see Fig. 3) varying in size when mature from 1 to 2 inches, streaked and mottled with varying shades of yellow, gray, and brown, are very well known. The caterpillars, as well as the adult noctuid moths, are most active during the night. The majority of the medium-sized, mottled gray-and-brown moths attracted to lights, are the adults of the cutworm caterpillars (see Fig. 4). Varying with the species, cutworms pass the winter as eggs, pupae, and adult moths, or as half-grown cutworms in the soil.

Our most commonly injurious cutworms in Oregon pass the winter as immature caterpillars in the soil. They are present in the early spring when the soil is prepared for planting and await with voracious appetites to attack the newly set plants or the seeded crop as soon as it appears above ground.

Nature of injury. Young plants just pushing through the ground are found cut off just below, just at, or just above, the surface of the soil, the wilted top lying near. The fruit of tomatoes, the heads of cabbage, and cauliflower are tunneled into and ruined. Occasionally severe outbreaks occur when the caterpillars become so numerous that the food supply is exhausted and they assume the army-worm habit.

Control. Poisoned bran mash is the standard remedy for cutworms. This material, when properly prepared and applied, is preferred to the vegetation by both cutworms and grasshoppers. The expense is not prohibitive and the results are quick and sure. As our most injurious cutworms are present in the soil at planting time a very excellent method is to treat the area with the bran mash following the preparation of the soil and previous to the setting of the plants in the field. This preventive treatment has frequently given practically perfect results in cutworm control.

Fig. 4. Cutworm moth (slightly enlarged).

Do not allow chickens in a treated field.

Late summer, fall, or early spring plowing, followed by frequent harrowing is, where practical, very effective in diminishing the numbers of cutworms. Frequent summer surface cultivation is likewise of value.

Cylinders of stiff paper or tin, pressed down into the soil about the plants and allowed to project about two inches above ground, give some protection.

Earthworms. Frequently requests are received for information on the control of earthworms. Corrosive sublimate is an effective remedy. A saturated solution of lime-water applied freely to the soil is of value. About two cupfuls of unslaked lime placed in a bucket of water, thoroughly agitated and allowed to settle will furnish the desired clear liquid. Tobacco dust thoroughly worked into the soil will also prove effective. Saturating the soil with corrosive sublimate solution (see corrosive sublimate) is suggested where feasible.

Collembola. Tiny insects resembling white ants have been observed to do considerable damage to spinach raised under glass. Soil sterilization by heat or chemicals should control these pests.

Grasshoppers have become a scourge at different times since our earliest history. As the land is brought under cultivation and more intensive farming is practiced, the attacks from these insects become constantly less frequent and less severe. Several species occur, but their habits and injury to crops are similar.

The winter is passed in the egg stage. The eggs are placed in the surface soil in a capsule-like sac or egg pod. Rather dry, bare, compact soil, such as is found in ditch banks, roadways, fence-rows, and run

down alfalfa fields, seems most acceptable for egg laying. The young hoppers appear in late April and May. They are very similar to the adult grasshopper in appearance, except in size and absence of wings. They are mature in from three to seven weeks.

Control. Various methods have been devised for controlling grasshoppers, including the use of hopper-dozers or catchers, spraying, brush dragging, trenching, cultivating egg beds, and killing by means of poisoned bait. Of all these the last mentioned has proved most efficient. To some extent the practice of plowing the egg beds or thoroughly cultivating them with a disk or spring-tooth harrow, can be used to advantage, but this is generally profitable only where the ground can be seeded to a crop.

The poison-bait method of control is commonly used when the grasshoppers are actually feeding on the crop and by prompt application of the bait at this time the loss can be kept at a minimum. A much better system, wherever it can be employed, is to poison the hoppers while they are small, thus both eliminating their destructive activity for that season and preventing them from depositing eggs. The young hoppers hatching there can be poisoned in the spring before they have had time to spread. Much less material is required to poison in these confined areas. Where effectively done, crop losses may be entirely prevented, and where vigorously followed up in an organized way practically wholesale destruction of the hoppers is possible.

Fig. 5. Adult "June bug." White grub in earth cell (enlarged).

White grubs. The larvae of May beetles or "June Bugs" are frequently the cause of much concern on the part of potato and truck gardeners. The grubs have hard, brown heads equipped with strong jaws for feeding upon the roots of corn, potatoes, grasses, and other vegetable and fruit crops. The normal home of the grub is in an old sod near a wood. The beetles feed upon the foliage of the trees and then visit adjacent fields to lay their eggs.

Control. Additional study of this pest is needed in order to devise effective measures of control. Soil fumigation or sterilization has been recommended but it has limitations. Old sod lands intended for potatoes, corn, or trucking should be previously planted to a crop which

will not attract the beetles. Alfalfa, clover, buckwheat, soy-beans, cowpeas, and flax are some of the crops said not to attract the beetles. Late summer or early fall plowing, which brings many grubs to the surface, crushing numbers of them and exposing others to the adverse weather conditions and birds, is a good practice, especially when the grubs are changing to beetles. When plowing is in progress hogs or poultry will be especially useful, since they will follow the plow and destroy large numbers of grubs.

Millepeds. These hard-shelled, worm-like animals feed on both plant and animal life. The slight good they may do by preying on other pests is overshadowed by their injury to cultivated plants. They destroy whole plantings of garden and truck crops, and do considerable injury to the fruit of tomatoes, cucumbers, and similar plants where they come in contact with the soil. The millepeds are not true insects, from which they differ by having two pairs of legs to the segment, while the adults of true insects have only three pairs of legs altogether. When disturbed, millepeds crawl over the soil very rapidly, and are easily distinguished by their many legs, brown color, and length of body.

Fig. 6. A milleped (enlarged).

Control. The poisoned bait as recommended for slugs is of some value against millepeds. Use of bits of poisoned potato worked into the surface soil is recommended by one authority and might be practical on small areas.

A dressing of ten parts of sulfur and one part of tobacco dust worked into the surface soil will repel millepeds.

Traps of sacking, boards, etc., as employed for slugs, would be equally effective for this pest.

Hot water will kill millepeds when they are near the surface of the soil, but does not act to any great depth.

Drenching the soil with mercuric chloride or kerosene nicotine oleate, or sprinkling it lightly with dry paris green and sugar (1 to 9) is recommended.

Two-spotted mites. If the foliage of beans, cucumbers, or any other crop in midsummer appears sickly yellow and drooping, the under surface of the leaves should be examined for mites. If infested, the under surface of the leaf will show numbers of fine webs with minute, reddish, spider-like creatures hurrying about. These mites pass the winter on weeds and other plants. In the spring they begin their attack upon the garden crops. Moist weather is detrimental to them, retarding their increase until dry weather prevails. During the growing season eggs are deposited among the groups of mites on the under surface of leaves. The young greatly resemble the adults, but have six instead of eight legs.

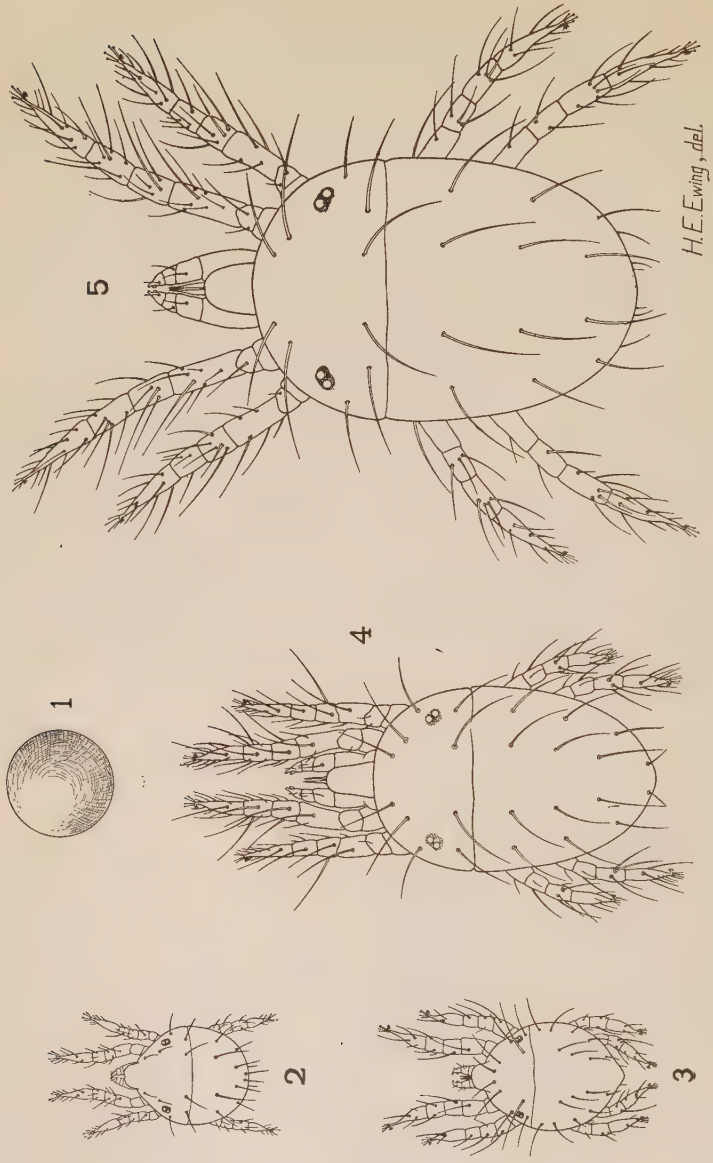

Fig. 7. Two-spotted mite (*T. telarius*). 1. Egg. 2. Larva. 3, 4. Nymph. 5. Adult. (Greatly enlarged.)

Control. Fumigation is precluded, for mites are very resistant to hydrocyanic gas or tobacco fumes. Measures recommended for controlling mites are: (1) Frequent syringing with clear water under pressure of at least 25 pounds. This operation dislodges the mites, causing them to fall to the ground, where they become lost in the mud. (2) Spraying with contact insecticides, as tobacco extracts, nicotine solutions, nicotine oleate, lime-sulfur, oil emulsions. (3) Frequent application of superfine sulfur is very effective in holding mites in check.

The garden slug. The garden slug is a very annoying and destructive garden pest. This repulsive, slimy, slow-moving creature is often incorrectly termed a snail. The adult is about two inches in length. It is a deep mottled gray or greenish-gray in color. The body is covered with a mucous slime which forms a slimy trail on any object over which the slug crawls.

Injury. Nearly all garden and truck crops are attacked. The slugs attack the plants mainly at the surface of the soil. They may feed down some distances below ground and also injure the heads of cabbage, lettuce, etc. The ugly feeding punctures they make afford a ready entrance for decay and often whole plantings are ruined.

Control. In planning a campaign for the control of slugs, it is advisable first of all to clean up all trash, crop remnants, and debris about the garden. For use in the garden a combination of a repellent spray applied to the plants and an attractive poison bait scattered on the soil will give excellent results.

Repellent spray. Bordeaux mixture 4-4-50 sprayed on the foliage of the plant proves an excellent repellent. The slugs will eat the sprayed foliage only under stress from lack of other food. Commercial dry bordeaux may be applied as a dust. Liquid bordeaux probably is a little more effective, but the powdered form sticks better to smooth, waxy foliage, such as cabbage.

The poison bait for use in combination with the spray consists of:

Calcium arsenate ..... 1 ounce
Chopped-up lettuce leaves.... 1 pound

Mix well and scatter in small heaps about the area to be protected. In case lettuce is not available, the tender foliage of cabbage, kale, clover, or other succulent leaves may be used. Of nearly equal value is the poisoned bran mash as recommended for cutworms. The essential factor is that the poison be calcium arsenate. Lead arsenate or the other poisons will not give an equal degree of efficiency in the poison bait for slugs.

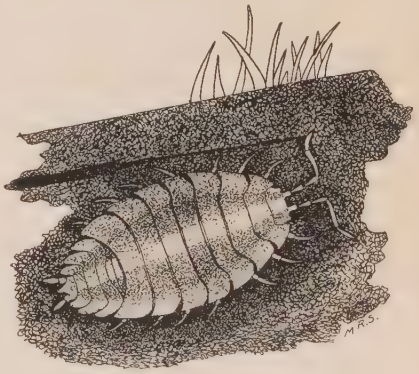

Fig. 8. A sowbug or "pill bug (enlarged).

Sow-bugs or pill-bugs. These creatures, sometimes mistaken for insects, are more troublesome to growers under glass. When disturbed

some forms roll themselves up into the shape of a round pill, hence the name "pill-bug." They are about one-half inch long, dark gray, and possess seven pairs of legs. Their usual abode is under some shelter such as decayed boards, flower-pots, in decayed manure, or any other dark place where decay is in progress.

Control. Sprinkle the surface of the soil with a dry mixture consisting of 9 parts sugar and 1 part dry paris green or poisoned bran mash (see page 8). A mixture of paris green, 1 part, white flour 2 parts, and sugar 2 parts is recommended. Dry tobacco dust, kerosene-nicotine-oleate, or crude naphthelene acts as a repellent. Prevent their multiplication by cleaning up and burning refuse. Pieces of freshly cut vegetables dusted with arsenate of lead or calcium arsenate are recommended.

Symphilids. Injury by symphilids is of so obscure a nature as frequently to escape detection. Planted seeds fail to appear above ground and newly sprouted plants wither and die. Where this pest is the offender, the attack is ordinarily so general as to destroy the stand. In extreme cases, three successive plantings of garden seed have been destroyed and even weeds killed out on the infested soil.

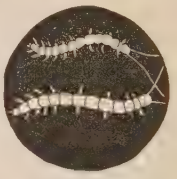

Fig. 9. Symphilids as they appear in the soil (enlarged 10 x).

Symphilids occur in the soil as minute, elongate, white creatures, hardly visible to the naked eye. Superficially, they resemble newly hatched centipedes. They attack the sprouts, stems, and roots of plants, excavating channels along the surface or tunneling minute pinholes through the plant.

Control. Effective control measures for this pest have not yet been developed. Frequent stirring of the soil with cultivators or the hoe is said to be of value probably by reason of the fact that frequently stirred soil dries out, causing the symphilids to migrate to damper soil. Sulfur planted with the seed is said to serve as a repellent. Beans appear particularly attractive to the symphilids, and may be planted as a trap to lure them. Dig out the infested beans in a few days and expose to the sun. Flooding for a period of two or three weeks where feasible has been recommended. Soil fumigants such as carbon bisulfide, paradichlorobenzine, and calcium cyanide have been used (see soil sterilization).

Thrips. Numerous species of minute fringed-wing insects, known commonly as thrips, attack various truck crops. Each species known to do serious damage is called by the name of the crop which it injures the most severely, as for example, onion-thrips, bean-thrips, pear-thrips, or prune-thrips, etc., although each feeds upon numerous other crops. Thrips are known to attack beans, beets, broccoli, cauliflower, cabbage, cucumbers, melons, pumpkins, squashes, parsley, tomatoes, kale, and turnips, feeding on the under side of the leaf. The leaf becomes covered with small, white spots where the insect has withdrawn the sap of the leaf for food. Wilting of the foliage results if the thrips are abundant and uncontrolled.

Control. Measures recommended for combating thrips are: (1) fumigation with calcium cyanide, or nicotine; (2) spraying with contact in-

secticides such as nicotine sulfate, paris green and brown sugar (paris green 2 tablespoonfuls, quicklime 2 tablespoonfuls, brown sugar 2 pounds, water 3 gallons), or dusting the foliage with superfine nicotine dust.

ASPARAGUS INSECTS

The asparagus-beetle *(Crioceris asparagi* Linn*).* This beetle has recently appeared in Oregon. The beetle is about .25 inch in length. The general color is bluish black; just back of the head the body is reddish and there are three orange blotches on each wing cover. The grubs are slug-like in form, gray in color, with the head and legs black.

The beetles appear in the field as the new asparagus shoots are coming up. They feed on the tender tips, scarring and discoloring the tissues. Eggs are attached endwise, usually two to seven or more, to the stems in rows. The young grubs soon hatch and they too feed on the tender growing tips. There are probably two generations in the season.

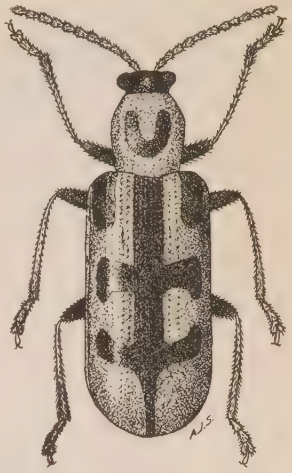

Fig. 10. Asparagus beetle (enlarged).

Control. Where the crop is being cut for market, the injury may largely be prevented by cutting the crop clean every three to five days. All volunteer plants should be destroyed. If a few plants here and there are left uncut, however, the beetles will congregate here and arsenical sprays or dusts may be applied for control. After the cutting season is over spray or dust thoroughly with lead arsenate, giving two or three applications at ten-day intervals.

Other pests. (See Symphilids.)

BEAN AND PEA INSECTS

Stored beans and peas possibly suffer more from insect attack than do the crops in the field. Two weevils are particularly bad in the stored seed.

The bean-weevil (*Mylabris obtectus* Say). The first evidence of infestation is usually in the stored seed. Many beans will show the round hole where the adult weevil has emerged, and an examination of the interior of others will disclose the grubs still at work inside. Several grubs may feed on the interior of a single bean.

The adult bean-weevil is one-eighth inch in length. It is covered with a coat of brown-gray and olive pubescence, giving the body a mottled effect. The wing-covers are shorter than the body.

The adult weevil deposits eggs within the pod in the field. The grubs hatch and burrow into the green beans, and are carried into storage with the seed. The beetles emerge in the bins and deposit eggs on the dried beans. The grubs soon hatch and burrow into the beans.

Control. Weevily beans should not be planted. The vitality of an injured seed is low and many will not germinate.

If infected seed is to be planted, just previous to planting pour in boiling water to kill the grubs; cool at once by the addition of cold water. Beans that rise to the surface are usually infested and should be destroyed.

Bean-weevils cannot be controlled in the field. In view of this fact and the fact that they multiply in stored beans, it is best to harvest the crop and as soon as dry to fumigate with carbon bisulfide or heat. Store

Fig. 11. Beans injured by weevil.

Fig. 12. a. Bean weevil. b. Larva (enlarged).

seed in weevil-proof bags or receptacles. Very finely ground clay or hydrated lime sprinkled heavily over the beans at time of storage is said to prevent reinfestation.

The pea-weevil (*Mylabris pisorum* Lec.). The evidences of injury due to the pea-weevil are practically the same as in the case of the bean-weevil. The beetle is larger and does not multiply in the stored seed.

Control. The treatments as recommended for the bean-weevil are equally efficacious for this pest, fumigation with carbon bisulfide or heat being the standard treatment for the stored seed.

Kerosene at the rate of ½ gallon to 5 bushels of seed is recommended. Simply pour the liquid over the peas, stir thoroughly, then spread the peas out so that the oil may pass off.

The pea-aphis (*Illinoia pisi* Kalt.). This plant-louse is of a uniform pea-green color, rather large as compared with most of the garden forms.

These plant-lice, when abundant, are able to sap the life out of a plant in a few days; they multiply rapidly and are very hardy. In addition to the garden pea, they feed on sweet peas, vetch, and clover.

Control. The contact sprays as applied for other plant-lice are fairly satisfactory for this insect. Kerosene emulsion is possibly the best of the contact sprays for the pea aphis. Tobacco extract (40 percent nicotine), 10 ounces to 50 gallons of water is also recommended.

Other pests. See Aphides. Striped or spotted cucumber-beetles, two-spotted mites, thrips, cutworms, seed-corn maggots, grasshoppers, and slugs.

CABBAGE INSECTS

Many of the insect pests of cabbage also attack other crops of the same family, including broccoli, cauliflower, Brussels sprouts, rape, and kale.

The cabbage-maggot (*Hylemyia brassicae* Bouche). The cabbage-maggot (Fig. 13) is a most serious pest of cabbage, turnip, cauliflower, celery, rape, kale, and radishes.

The larva is a typical maggot, waxy white or yellowish in color. The body is cylindrical, ending bluntly behind and tapering to a point toward the head. When mature it measures about .32 inch in length.

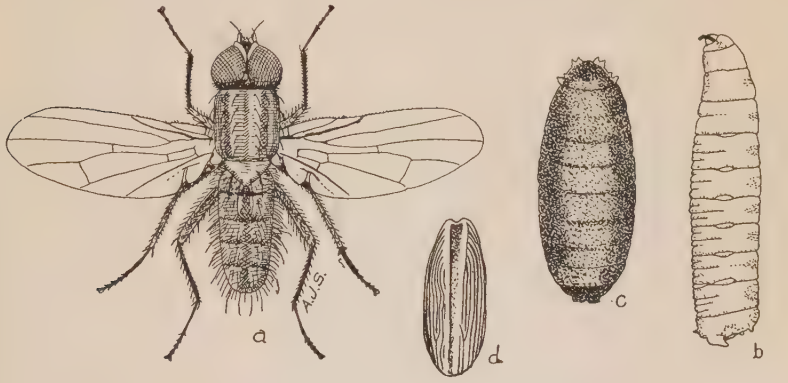

Fig. 13. Cabbage and radish maggot. a. Adult fly. b. Larva. c. Pupa. d. Egg. (Enlarged.)

The pupa consists of a small brown case or puparium some .2 inch in length. It occurs in the soil about the infested plants.

The adult insect is a two-winged fly, not unlike the common housefly. It is smaller in size and dark ash-gray in color with a distinct hump. When at rest, the wings extend some distance beyond the abdomen and overlap.

The egg is small, measuring only .04 inch. It is white, and by the keen observer may be seen lying on the soil close to the stem of the food plant.

The adult flies appear in the early spring and seek their favorite food plants for egg laying. The eggs hatch in from four to ten days, and the young maggots burrow at once into the stem or root of the tender plant. The maggots reach maturity in from a month to six weeks, pupate, and emerge again as adult flies. From this time on until late fall, the insect is usually present in all stages of development.

Symptoms. A few days after the cabbage plants are set in the field, they show a sickly bluish cast. Upon pulling up the affected plant, the tunnel and the repulsive maggots are discovered.

Control. Of a great variety of control measures recommended and practiced, the screening of the cabbage seed-beds and the use of corrosive

sublimate on the cabbages and similar plants in the field are the most practical and effective treatments.

Screening of the cabbage seed-beds has proved a very satisfactory and paying method of control. Cabbage plants are often infested while yet in the seed-beds and the maggots carried with the plants when they are transferred to the field. A frame of twelve-inch boards, with wires across the top to prevent the cover from sagging, and the whole then covered with coarse cheese-cloth (twenty threads to the inch) making the frame fly-proof, serves very well.

By keeping out the adult female fly and thus preventing egg deposition, the plants are kept free from maggots. This frame should be removed, in the case of cabbages, a few days before the plants are transferred to the field to enable them to become hardy. A bed which is to be protected in this way should be located on well-drained and well-prepared soil, as cultivation under the cover is impracticable.

Corrosive sublimate at the rate of 1 ounce to 12 gallons of water is a most efficient material for use on permanent plantings of cabbage, cauliflower, and similar plants. About 2 liquid ounces to the plant should be used, the material being simply poured on the surface soil about the plant. Four treatments should be given, the first treatment three days after transplanting and succeeding treatments at ten-day intervals until four have been made.

A barrel in the back end of a wagon, fitted with two leads of hose and stop cocks, affords a fairly rapid method of application.

Dissolve the corrosive sublimate in 1 quart of hot water in a glass, wooden, or earthenware vessel. Dilute to 12 gallons.

Reasonable precaution should be observed because of the poisonous nature of the corrosive sublimate.

Another remedy of value in small gardens is the use of squares or disks of tarred paper to protect the plants against the egg laying of the fly. To make protectors, cut 3-inch squares of tarred building paper and make a slit from one side to the center and several short slits like a star at the center. Place the square around the plant just after setting out and press the paper closely around the stem and down against the ground. The paper squares must fit snugly to keep out the fly.

Fig. 14. Typical appearance of aphis infested cabbage leaf.

Destroy all waste roots and refuse tops as soon as the crop is removed. Plow the land to a depth of four inches or more. As far as possible destroy all wild mustard and similar weeds about the field.

Rotate the crops so that plants of the Cruciferae group occupy the soil but a single season. The flies are weak fliers and do not usually travel far.

The use of a quick-acting fertilizer and frequent surface cultivation are of value.

The cabbage-aphis (*Brevicoryne brassicae* Linn). This aphis is a very serious cabbage pest. It attacks all members of the group to some extent. Patches of rape and kale are often observed with many of the leaves absolutely covered with aphids and the depressions formed at the base of the leaves filled with the cast skins, parasitized plant-lice, and the honey dew excreted by them. Small cabbage and rape plants are often weakened by the attack of this aphis so that the plants amount to nothing.

Control. Contact sprays or dusts as for other plant-lice are effective, but several applications are often necessary to reach all of the aphids in the curled leaf.

Seed-beds. Plants are often infested in the seed-bed. They should either be dipped at transplanting time or fumigated with tobacco paper. Whale-oil soap, 1 pound to 8 gallons of water, makes a very effective dip.

Fig. 15. Butterflies, adults of the imported cabbage-worm (*Pieris rapae* L.). (enlarged).

The imported cabbage-worm (*Pieris rapae* L. . The imported cabbage-worm is a heavy feeder on the leaves of cabbage and closely allied plants. The worm is velvety green in color, with a faint yellow stripe down the back and a row of yellow dots down each side. The adult is a white butterfly (see Fig. 15), a very familiar figure about the garden, though not always recognized as an enemy. These butterflies are among the first to emerge in the spring and they soon commence to lay eggs on the leaves of any available food plant. The young worms feed greedily and are mature in ten to fifteen days. The chrysalis is green with a sort of bonnet effect and is attached to the leaf or other support by means of a silken band about the center. There are at least three generations during a season.

There are a number of parasites which prey on this worm very effectively and in favorable seasons may even prevent it becoming a serious pest.

Control. Spray or dust the young plants with one of the arsenicals. The dust is usually better for small plants. In fact if an arsenical dust is

used on the plants at intervals of two weeks during growth until the plants begin to head, injury by cabbage-worms will be extremely slight. It is well to add soap to the liquid sprays as a sticker for the slick foliage. The treatment should be repeated frequently until the heads are well formed.

Hot water (150° F.), or a salt solution, will kill the worms if they are wet with it.

The diamond-back moth *(Plutella maculipennis* Curt.*)*. The diamond-back moth as a larva is comparatively small, measuring when mature about .3 inch. It is of a pale green color, very active, and easily disturbed. These worms attack especially the central heart of the cabbage and cauliflower head.

Control. Singularly enough this tiny worm does not yield to the standard strength arsenical sprays. In tests conducted by the Oregon Experiment Station the worm was controlled by spraying with 1 ounce paris green to 3 gallons of water in which 3 ounces of soap had been dissolved.

Other pests. Cutworms, flea-beetles, thrips, slugs, wireworms.

CORN INSECTS

The corn-ear worm (*Heliothis obsoleta* Fab.). The tips of the ears of corn are often found eaten away, the silks cut off, and the whole ear presenting a most uninviting combination of injured kernels, decaying material, and frass. Usually a further search reveals the offender, a smooth, greasy, cutworm-like larva, about one and one-half inches in length, rather slender, and with varying shades of color and markings. (Fig. 16.)

Sweet corn, pop-corn, and field corn are favorite food plants in about the order named; it feeds also on peppers, peas, cow-peas, beans, and many other vegetables and fruits.

The adult of the corn-ear worm is a moth, measuring, with wings expanded, about $1\frac{3}{4}$ inches. These moths are night fliers and are often attracted to the lights at night.

The moths appear in the spring about the time corn is knee high. At this time the eggs are deposited on a variety of plants. The young worms which hatch from the eggs feed and grow to maturity. The new generation of moths appear just in time to deposit eggs on the silks of the developing ears of corn. From these eggs hatch the worms which play havoc with the tips of the ears.

Control. The numerous plants fed upon in the early spring and the fact that the moths can fly for some distance to deposit their eggs are factors that make the control of this pest especially difficult.

Rotation. Planting the corn some little distance from land occupied by corn the past season will prove of some value. Early planting is recommended. In this way the corn will be in the silk before the moths are out in numbers to infest it.

Sprays. For valuable plots of sweet and pop-corn, of which only clean ears are salable, and in corn grown for seed, dusting the silk with a mixture of equal parts of powdered arsenate of lead and sulfur or wood ashes gives good control. This material must be dusted on the silks

Fig. 16. Corn ear, showing worm and injury (reduced).

every eight days, from the time the silks shoot until they become dry. The dust is applied by hand, using a bellows dust gun or a can with a perforated top, "peppering" the silks. The silk and tip of each ear must be lightly dusted.

Fall, winter, or early spring plowing, followed by frequent summer surface cultivation, is the practice followed in the great field-corn districts of the Middle West. Where practiced consistently, these cultural methods generally suffice for the conditions there.

The seed-corn maggot (*Hylemyia* sp) attacks sprouting seed of corn, beans, peas, cucumbers, and melons and has been recorded as feeding on seed potatoes, onions, cabbage, and even certain kinds of animal matter such as grasshopper eggs and organic fertilizers. In cold, wet, backward seasons the maggots may occur in abundance in spring plowed alfalfa or grass sod lands. In such fields the maggots will feed on the planted seeds which have softened in germination or from decay. The maggots burrow into the seed-leaves, destroying them, and then burrow into the stem.

The flies of the seed-corn maggot closely resemble those of the cabbage-root maggot and onion-maggot and the life-histories of the three are similar.

Control. The injury during cold, wet seasons to germinating seed may be prevented in large measure by planting seed shallow. New land, or alfalfa sod recently turned under, or soil containing much vegetable matter should not be planted to susceptible crops, especially in cold wet seasons.

Other pests. Twelve-spotted cucumber-beetle, cutworms, grasshoppers, millepeds, and wireworms.

CUCUMBER, CANTALOUPE, AND SQUASH INSECTS

Western twelve-spotted cucumber-beetle (*Diabrotica soror* Lec.) is probably the most serious of the insect pests attacking this group. It is a very general feeder, and its attack is by no means confined to these plants. Beans, potatoes, turnips, and similar truck crops suffer in much the same way. It is a serious pest of ornamental shrubs, devouring the buds and blighting the growing tips. Similar injury occurs to orchard trees; namely, blossoms are eaten, forming buds are blighted or devoured, and the forming fruit is scarred and malformed by this active beetle. The silks, tassels, and even the green corn prove an inviting food at times.

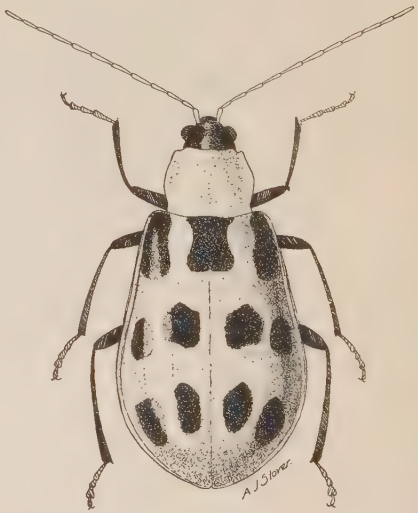

Fig. 17. Western twelve-spotted cucumber beetle (enlarged).

The larvae feed on the sprouting seed of grain and may also girdle or burrow into the roots of other food plants. They also mine into the stems and rinds of the melon, cucumber, and squash, where these fruits are in contact with the soil.

The most noticeable injury of this pest, however, is the work of the beetles on the foliage of the above plants. They will collect in numbers,

beginning their work when the young plants first appear above ground. They often kill out whole plantings or so deplete the stand as to necessitate replanting. On the older plants they skeletonize the leaves, leaving only a gauze-like vein structure.

The beetle is only one-fourth inch long, yellowish green in color, the wing-covers marked with twelve black spots. The mature worm is a little less than one-half inch in length. The body is cylindrical, waxy white or yellowish in color. The head, prothorax, and anal segment are dark brown.

The winter is passed in the adult stage. These beetles become active during March. The wild gourd or "man-in-the-ground" is a favorite food plant at this time. They may also be found feeding on the bloom of the false dandelion. Whatever the food plant, they feed ravenously, attacking with apparently equal gusto, dirty or clean, tough or tender, sprayed or unsprayed foliage. After about ten days of feeding, many of the beetles become restless and rise high in the air and fly to new fields. These migratory forms constitute the early generation which attacks the young cultivated plants just pushing through the ground. A very common practice at this time is for the beetles to collect just at or just below the surface of the soil, feeding on the stems and sprouts. The plants are often girdled or cut off, the work much resembling that of a cutworm.

About this time the beetles become more choice in their food habits, avoiding anything but the more tender and clean growth. Any dust or spray acts more or less as a repellent, though where carelessly applied it may but serve to increase the injury by driving the beetles down to the untreated stems, where the practice of girdling will become more pronounced.

The new generation of beetles appears in numbers about June 30 to July 12. For a short period these beetles feed voraciously, devouring both sprayed and unsprayed foliage. After a few days, as with their predecessors, they refuse all but the very choice, tender portions of the plant.

Control. It is seldom that any one treatment will prove entirely effective for this pest. The "trap crop" method gave excellent results in some of the tests at the Oregon Experiment Station. A number of suggestions are given and from the whole the grower may select such as best fits his conditions.

Protective coverings, consisting of boxes, hoops, or bent wires covered with cheese-cloth, or commercial paper cones, serve very well for the protection of small plants. Wire screen cones are also recommended and were used in station tests. These cones consist of the regular screen wire cut in half-circles, the straight edge then drawn together and sewed with wire. Obtain wire gauze 34 inches wide; cut it in squares 34 by 34 inches. Measure with a piece of string the distance from the center to the side, and with a piece of chalk describe a circle. Now cut with a pair of tinner's shears and bisect the circle. This will form two cones.

These protectors are fitted down snugly about the young plants and the earth drawn up about the base. The cones may be used for a number of years. They should be dipped in paint or painted, both to prolong the life and to decrease the size of the openings.

Planting an excess of seed will be of some value where a stand is desired at all hazards.

Clean culture. All of the old vines and trash in the field should be destroyed after the crop is removed. The destruction of the wild gourd will remove one very inviting breeding place.

Fertilization with some quick acting agent has been suggested to aid young plants to make a quick growth and thus outgrow the injury.

Trap crop. Taking advantage of the apparent preference of the beetles for squash and beans, these crops may be used in conjunction with other crops as the trap crop. The squash is probably more inviting under most conditions. The trap should be planted about the border of the fields, and on large plantings a few rows should be placed through the field. The number of plants in the trap must be left largely to the judgment of the owner.

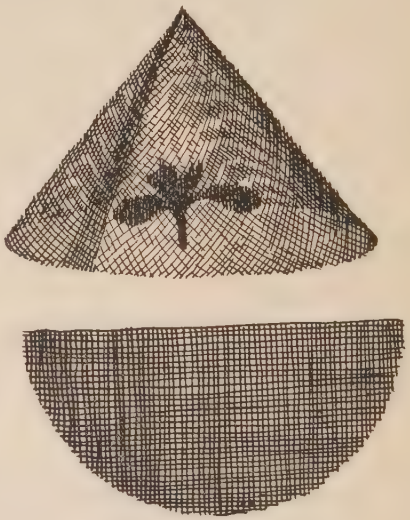

Fig. 18. Method of cutting wire cones to protect from Diabrotica beetles.

Proceed as follows: Some ten days before the planting of the main crop, plant a few hills of the trap crop; at the time of planting the main crop plant more of the trap crop; some two weeks later make a third planting of the trap crop. When the first beetles appear, spray or dust the main crop with an arsenical. Repeat this treatment as often as the effect of the previous application is lost. This treatment of the main crop must be thorough, care being taken to treat every portion of the plant above and below. The treated vines will prove distasteful to the beetles and they will collect on the trap crop, where they may be destroyed by some mechanical means.

Poison sprays. A mixture of lead arsenate 1 part by weight and landplaster 20 parts by weight dusted on the plants is recommended as of value. Apply the dust as soon as the plants appear above the ground and repeat every few days or whenever the plants have outgrown the dust. Repeated applications of a 2 percent nicotine dust are of value.

A spray consisting of calcium arsenate 1 ounce, hydrated lime 1 ounce and water 1 gallon should be effective.

Western striped cucumber-beetle (*Diabrotica trivittata* Mann.). This is very similar to the spotted beetle in the general food habits, life-history, and injury. The beetle is about .4 inch long, of a rather whitish-green color, and with two black stripes down each wing cover, which, when the beetle is at rest, appear as three black stripes; hence, the name.

Control. Same as for western spotted cucumber-beetle.

Other pests. The melon aphis (*Aphis goosypii* Glover), aphides, two-spotted mites, cutworms, grasshoppers, millepeds, and seed-corn maggot.

Fig. 19. Striped Diabrotica beetle and typical injury to cucumber leaf (enlarged).

ONION INSECTS

The onion-thrips (*Thrips tabaci* Lind). The onion-thrip becomes, in an occasional season or district, a serious onion pest. Where for any reason the growth of the crop is checked for even a short time the injury may become extremely severe.

The adult thrip is very small, measuring about .04 inch. It is of a pale lemon-yellow color, with a blackish tinge. The thrip is very agile, moving with a gliding motion, the body twisting and turning as it travels. The female deposits very minute eggs on the surface of the leaf. The young nymphs resemble the adults, but are smaller and lighter in color. The various stages are of short duration, and there are several generations during the season. Winter is passed as nymphs, pupae, and probably also as adults. They occur in trash and refuse tops about the field. While onions suffer most, cabbage and kale, cucumbers, tomatoes, and several of the ornamentals are also subject to attack.

Injury is due to a rasping of the surface of the leaf. The tops of injured onions appear whitish or blighted. They wilt down and the bulb itself does not grow. An examination of the inner tender surface of an infested plant reveals groups of these minute insects hurrying about.

Control. The onion-thrips illustrate to a remarkable degree the value of good farm practices in insect control. The grower who has the best prepared seed-bed, follows the best cultural practices to conserve moisture, uses fertilizers intelligently—in a word, the grower who has his crop in such thrift that brief periods of drouth or adverse conditions do not seriously check the growth of the onions, seldom suffers serious thrip injury. Good farming is the very best control for onion-thrips.

While fairly expensive, rather light applications of nicotine dust are effective, and for ease and rapidity in application and effectiveness it finds especial favor in onion-thrips control. Apply when temperatures are above 60° F.

Black Leaf 40, 1 part to 1600 parts of water, with the addition of whale-oil soap, 4 pounds to 100 gallons of the solution, will control the thrips. Kerosene emulsion as a 7-percent solution is equally good. Whale-oil soap, 1 pound to 6 gallons of water, is also recommended. Any of these solutions, to be effective, must wet the insect. Spray thoroughly, driving the spray into the sheaths and also wetting the soil about the stem.

The onion-maggot (*Hylemyia antiqua* Meigen). The onion-maggot attacks the onion much the same as the cabbage-maggot attacks the radish. Infested plants, where small, may be killed outright. Older plants, where infested, may decay in storage.

The various stages and life-history and habits of this pest are so similar to those of the cabbage-maggot that the previous discussion (see p. 23) will serve for this pest also.

Control. The standard control recommended in the East is the sweetened poisoned bait, which under favorable conditions gives a fair degree of protection. Its use as a supplement to the cull onion trap crop in tests made by the Oregon Experiment Station has given promise of good results.

Sweetened poison spray formula:

Sodium arsenite	1/5 ounce
Water	1 gallon
Molasses	1 pint

Volunteer onions in the field act as a lure for the flies at egg laying time. Field observations indicate that the majority of eggs are deposited on or adjacent to these volunteer plants. In the absence of volunteer onions in the field, cull onions may be planted about six in a small circle to every one hundred feet in the row. Plants of a rather low, bushy growth are most attractive. The cull onions should be planted so as to have a low bushy growth by the time the onion flies are on the wing or before the field onions reach a height of 1½ to 2 inches. As soon as the first flies are observed shallow cans containing the sweetened poison bait should be placed on the soil in the center of the circle of cull onion plants. The flies will be attracted to the onions for egg laying, sip some of the poison and die, thus checking any further multiplication of the flies. Later remove from the field and destroy all trap onions in order to kill the maggots infesting them.

Experiments in Illinois* have shown that the onion-maggot can be controlled by spraying the young plants as soon as they are an inch high with bordeaux oil emulsion. The oil emulsion is made by boiling together 1 gallon of light-grade lubricating oil having approximately 90 percent viscosity and .88 specific gravity with 2 pounds of potash fish-oil soap and 1 quart of water. This oil emulsion is added to a 4-4-50 bordeaux mixture at the rate of 1½ gallons of the stock solution to 48½ gallons of bordeaux. Five applications at weekly intervals are recommended.

Other pests. Wireworms and cutworms.

*W. P. Flint and C. C. Compton. A new method of controlling the onion-maggot Jour. Economic Entomology, v. 18, No. 1. Feb., 1925.

POTATO AND TOMATO INSECTS

The western potato flea-beetle (*Expitrix subscrinita* Lec) (see Fig. 21) is probably the most serious insect pest of the potato and tomato in Oregon. The beetles eat small, irregular holes in the leaf. This in itself might often prove of lesser importance, but these feeding punctures seemingly invite the attack of a fungus, which spreads out from the puncture and eventually affects a considerable portion of the leaf's surface (see Fig. 20).

The larvae tunnel into the developing tubers underground. These feeding tunnels extend but a short distance into the potato.

Fig. 20. Potato foliage, showing injury due to flea-beetles.

They give the surface of the potato a roughened, pimply appearance which may seriously affect the market value.

This insect feeds on a variety of plants, but apparently confines its serious attack to a small group of cultivated plants, of which the potato, tomato, pepper, and eggplant are most important.

The adult flea-beetle is nearly one-twelfth inch long, slightly oblong in form, and a dark metallic brown in color. The femur of the hind leg is much enlarged, giving the insect its ability to jump quickly like a flea when disturbed.

When mature the larva forms a small earthen cell in the soil and transforms to a pupa. The pupa is white in color and about the size of the adult beetle.

Life-history. There are two generations during the year. The beetles pass the winter in sheltered nooks about the field. They appear in late March and early April and feed on available weeds or plants of the potato group, later transferring their attack to cultivated plants.

The larvae are present in the soil during June and early July. The adult beetles continue to feed on the foliage during this time. The beetles of the new generation commence emerging about July 20. These beetles in turn attack the foliage and deposit eggs in the soil. They fly readily and thus migrate to the new fields of late potatoes. The larvae of the second generation feed and grow through August and early September. The first adult beetles of the fall generation appear about Octo-

ber 10. These beetles feed for a time on the foliage of various plants and then seek suitable places for hibernation.

Control. The Western potato flea-beetle avoids sprayed foliage. This makes it an insect difficult to control with the ordinary arsenicals as applied for most leaf-eating pests. Bordeaux mixture (see page 11), applied for the potato fungous troubles acts as a very effective repellent for the flea-beetle. By far the majority of the flea-beetles feed on the under surface of the foliage, and a spray to control them must, therefore, be directed as an underspray. Repeated applications are necessary for best results.

Arsenate of lead, 3 pounds to 50 gallons with the addition of 2½ quarts of good cane sirup, is suggested as a spray with possibilities.

For newly set tomato, pepper, and similar plants, two different treatments are recommended by some of the successful growers.

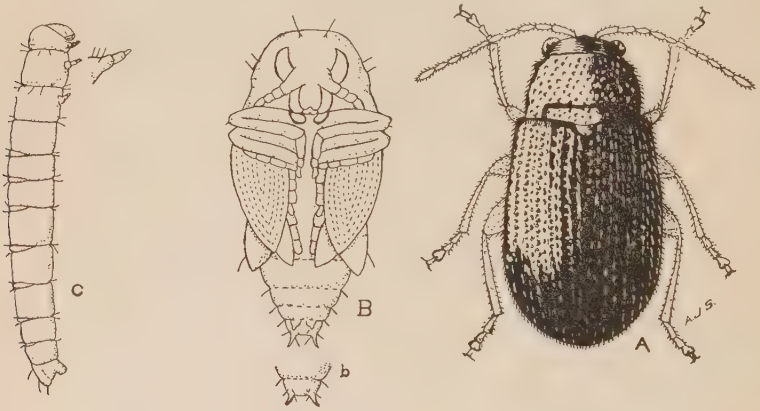

Fig. 21. Western potato flea-beetle. a. Adult. b. Pupa. c. Larva. (Enlarged.)

Cylinders of tin or paper (false bristol board works very well) about the dimensions of a tomato can, placed about the plant, have given satisfactory results.

Use of strips of paper suspended over the plants on a string stretched the length of the row is highly recommended by one grower.

The Colorado potato-beetle *(Leptinotarsa decemlineata* Say*).* This very injurious potato insect was but recently introduced into Eastern Oregon. As yet it is confined to a comparatively small area of the eastern portion of the state and does not occur in Western Oregon so far as known.

The insects pass the winter in the soil as adult beetles. They appear in the fields in the spring just as early potatoes are sprouting. They feed on the tender tips of the young plants and after a few days begin egg deposition. Eggs are deposited in compact masses on the under surface of the leaves. The larvae are slug-like, deep reddish in color, and they too attack the foliage of the potato. When mature they drop

to the soil and tunnel in to change again to adult beetles. Through most of the Middle West, there is a second generation of the beetles and grubs in midsummer.

Control. Poison sprays are the standard treatment for the potato-beetle. Two applications of spray should be made, the first as soon as the beetles appear on the young plants in the spring and a second about two weeks later. The dust spray (see page 8), is excellent for the earlier application. Calcium arsenate is the preferable poison. Lead arsenate,

Fig. 22. Colorado potato beetle. a. Adult beetle. b. Eggs. c, d. Larvae.

however, will control. Use the poison at the rate of 1½ to 2 pounds powder to 50 gallons of liquid. When spraying with bordeaux for potato diseases the arsenate may be added to the bordeaux spray.

The stalk-borer *(Papaipema nitella* Guen*).* This borer tunnels into the stalk of the potato and tomato, eating out the heart and thus killing the stem attacked. The mature larva measures one inch in length. The color is purplish brown, marked with five longitudinal white stripes. All but the median stripe are absent on the four segments near the middle of the body, giving the worm a characteristic divided appearance. The mature larva eats an emergence hole in the stalk and then pupates in the burrow. From this pupa there emerges a fawn-gray moth. This moth emerges in late August and deposits eggs in the wild grasses. The worms hatch in the spring and migrate to the cultivated plants.

Control. Cut out infested stalks and burn. Keeping down weeds about the field will help.

Blister-beetles *(Meloidae).* The blister beetles are elongate, cylindrical insects with soft bodies, long legs, and flexible wing covers. They have a broad, round head, attached to a narrow thorax by a distinct, slender neck. They are sometimes termed old-fashioned potato bugs. The average length is a little more than one-half inch. They vary in color from dull shades of black, gray, and brown to bright metallic hues, variously striped and shaded. Where they occur in numbers, an offensive odor is quite perceptible.

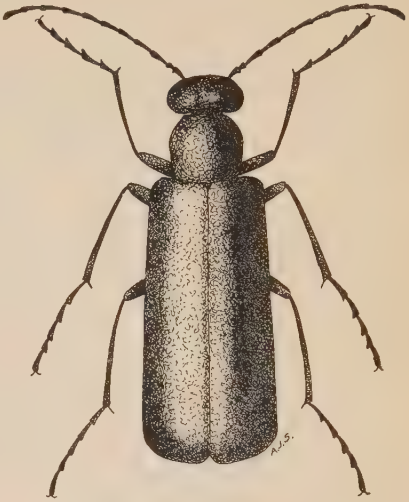

Fig. 23. A blister-beetle (enlarged).

Injury. The adult beetles feed on the foliage of almost any of the truck crops. Usually they appear in the field in a great swarm, attacking some particular crop to the exclusion of all others, until this food plant is thoroughly riddled. The immature forms of the blister-beetle are beneficial, the young of some species feeding on the egg sacs of the grasshopper.

Control. The beetles may often be driven from the field by simply sweeping over the plants with a brush, driving them with the wind. Another method is to prepare a windrow of straw along the windward side of the field. Fire this straw, after dusk, and sweep over the field, driving the beetles into the burning straw. In potato fields, a paddle and bucket of suds will serve very well, simply knocking the beetles off into the bucket.

The arsenical sprays will check them in time, but as the poison acts rather slowly, some mechanical means is usually more satisfactory where the blister-beetles occur in swarms. Lead arsenate (powder) 2 pounds to 50 gallons water is recommended. A somewhat stronger spray providing the plants are not injured is an advantage. Recent work in Louisiana indicates that sodium fluosilicate and lime in equal parts are of value in controlling these insects. Calcium fluosilicate also should control.

Wireworms (*Elateridae*). Wireworms occur in the soil as elongate, cylindrical, active, worm-like larvae, with a hard, smooth, waxy, reddish-brown surface and with the body segments well defined. The worms vary from one-half inch to an inch in length. The adults of the wireworms are brownish beetles known as jumping-jacks or click beetles because of their habit of throwing themselves with a snapping or clicking sound (see Fig. 24).

The normal habitat of most species of wireworms is the grass lands. The eggs are deposited here and the young worms feed on the grass

roots. They spend from two to five years in the soil as wireworms before they become mature. Where sod land is brought into cultivation the worms present in the soil often attack the cultivated crop. The corn wireworm appears to be most troublesome on heavy poorly drained soils.

Injury. Grain and potatoes suffer most. The worms bore into the seed and eat the germ of the grain and excavate tunnels in the potato tuber (see Fig. 25). Other seeds, bulbs, and root crops often suffer from a similar attack by wireworms.

Control. Soil-infesting insects present a difficult problem in effective control. Wireworms are especially difficult to handle. Baits for the larvae and traps for the adults, while involving a considerable amount of labor and patience, are effective and practical for gardeners and truck growers.

Bait for wireworms. The most successful bait appears to be rice bran balls as employed by the Japanese gardeners. Roast the rice bran in shallow pans in the oven, stirring frequently, until well browned. Moisten the bran and mold into compact balls, about the size of a golf ball, and let dry. If possible bait the soil in early spring before cropping. In the first treatment place the bait in rows 10 feet apart and 8 feet apart in the row. After locating the centers of infestation, as indicated by the abundance of the wireworms attracted to the baits, increase the number of baits on the heavily infested areas. Where a crop is present, place the bait between the rows, 10 feet apart in the row.

Fig. 24. Adult wire or click beetles (enlarged over 2X).

The process of setting the bait consists in gouging out a shallow hole with a hoe, dropping in the bran ball, and kicking the soil into place. Place sticks or indicators of some sort near the planted bait. At weekly intervals visit the baits, break them open carefully, and destroy the wireworms; reset the baits, increasing the number where necessary.

Traps consisting of piles of coarse straw, about three piles to the acre, may be used to attract the adult beetles. The successful use of traps depends upon one's ability to recognize the beetles, upon having the field free from all other trash and debris, keeping the piles of straw loose and fairly dry by frequent turning, getting these piles on the field in early spring, and frequently examining the traps. When beetles are found in the piles burn them at once.

Deep and thorough cultivation of the soil in late July and August is recommended as of value in destroying the pupal cells, and thus reducing the number of beetles the following spring. A short rotation of crops in which the land is not left in grass for more than two or three years is said to be of value. Peas, mustard, and buckwheat are said to be relatively immune to wireworm attack and may be used to advantage between sod and corn or other susceptible crop.

Tomato-worms or horn-worms (*Protoparce* spp.). The large, green, horned caterpillars that one occasionally finds stripping tomato plants are the young of the large humming-bird moths. This moth has a wing expansion of 4 to 5 inches. The front wings are ashy gray marked with irregular brown and black lines. The hind wings are whitish with a broad gray band on the outer margin and crossed with four

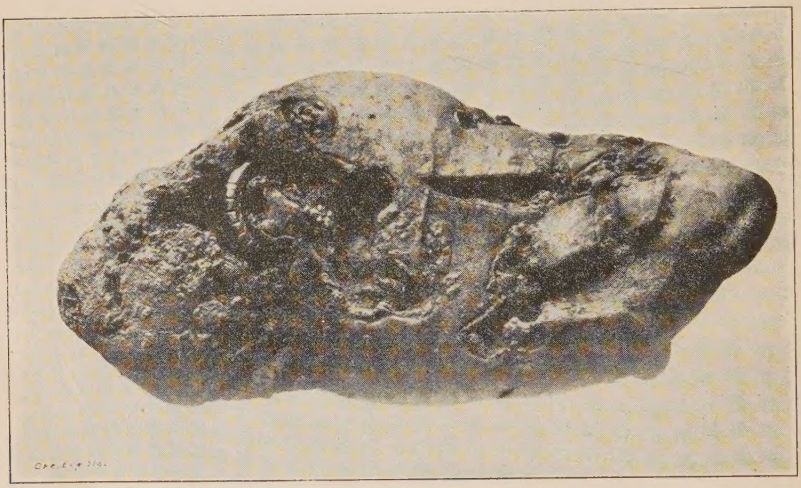

Fig. 25. Potato tuber, showing wireworm injury and larva (reduced).

black bands, the middle pair being sharply zigzag. The moths appear in the late spring and may be seen in the evening or on dark days hovering over flowers from which they suck nectar.

The eggs are deposited singly on the under side of the leaves. The eggs hatch in 3 to 8 days. The caterpillars grow rapidly, reaching maturity in three weeks to a month. The full grown caterpillar is 3 to 4 inches long, greenish-brown marked on side with V-shaped white stripes and possessing an evil looking but harmless horn at the posterior end.

When mature the caterpillar enters the ground and there in an earthen cell transforms to a dark brown pupa. The number of generations varies with the length of the season.

Control. Hand picking is advised in small gardens and even in larger fields where the caterpillars are not numerous. The caterpillar is not easy to see as it rests motionless on a stem, its colors blending with the green of the foliage. It may often be discovered by the droppings of the worm on the ground. Calcium arsenate dust is the standard remedy for these worms on tobaccos.

Tomato fruit-worms. Certain species of cutworms and the corn earworm cause growers much trouble by burrowing into the ripening fruit (see Corn, Cutworms).

Control. Two or three applications of lead arsenate at intervals of ten days or so will keep these worms partly under control. Hand picking is advised.

Other pests. Western twelve-spotted cucumber-beetle, tarnished plant bug, cutworms, grasshoppers, aphides, and white grubs.

RADISH AND TURNIP INSECTS

Radish-maggot (*Hylemyia brassicae* Bouché). The same species of fly that attacks cabbage also attacks radishes, turnips, rutabagas, and wild radishes. Infested radishes, turnips, etc., show the tunnels of the mag-

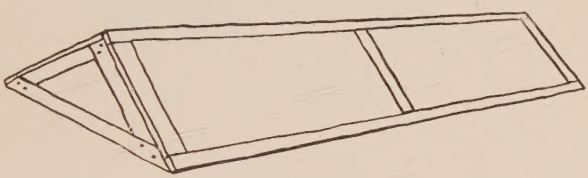

Fig. 26. Radish maggot screen frame, illustrating type of construction suggested for protection of radish beds.

gots, the interior being often decayed and filthy. The maggot is so destructive that very little attempt on the part of market gardeners is made to raise this crop after the flight period of the fly begins.

Control. Screening has proved a satisfactory protection for radish plants. This may be accomplished by the use of a light frame constructed as an inverted trough (see Fig. 26) and covered with wire screen or coarse cheesecloth, which proves a most handy and satisfactory protection for radish beds. The approximate dimensions of the radish screen frame are 10 feet long, 2½ feet wide, and 1 foot high. These frames are light enough to move with reasonable ease, and where given some care will last for several seasons. The slight shade afforded assists the growth of the radishes. With three such frames to be used over successive plantings one is assured at all seasons of delectable radishes free from maggots.

Other pests. Garden slugs.

RHUBARB INSECTS

Fig. 27. The green dock-beetle (enlarged over 8X).

The green dock-beetle (*Gastroidea cyanea*). This metallic green or bluish-green beetle has been frequently reported as doing damage to rhubarb. The larvae and adults feed upon the leaves, eating around the edges or making irregular holes in the leaf.

The insects pass the winter in the adult stage, and emerge in great numbers the latter part of March and April. They feed ravenously before egg laying, which begins in April. The larvae as soon as they emerge, begin feeding at once. They mature in two to three weeks. Pupation takes place in the soil.

Control. If the beetles are not too numerous, hand picking or brushing the beetles into oily receptacles is suggested. Arsenical sprays or dusts are recommended, but no poison should be applied to crops just ready for market.